Air War College

HIGH ALTITUDE RADIATION EXPOSURE
IN THE SR-71: A PRELIMINARY REPORT

PROFESSIONAL STUDY

No. 5481 **By** Rufus M. DeHart

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14 April 1983

SUBJECT: Paper - High Altitude Radiation Exposure in the SR-71: A Preliminary Report by Lt Colonel Rufus M. DeHart

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REPORT NO. 5481

HIGH ALTITUDE RADIATION EXPOSURE IN THE SR-71
A PRELIMINARY REPORT

by

PII Redacted

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AN ARTICLE SUBMITTED TO THE FACULTY

MAXWELL AIR FORCE BASE, ALABAMA

April 1974

ABSTAINER

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AIR WAR COLLEGE ARTICLE SUMMARY
NO. 5481

TITLE: High Altitude Radiation Exposure in the SR-71 - A Preliminary Report

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A study to measure radiation received by SR-71 crews at high altitudes began at Beale AFB, California in 1971. Data gathered during the first eighteen months are presented. Radiation was measured by a thermoluminescent dosimeter provided by the USAF Radiological Health Laboratory (AFLC). Forty-seven SR-71 crewmembers flew a total of 7000 hours (2275 hrs. above 60,000 ft.) in latitudes from 10°N to 50°N. Radiation received by these crews was negligible. The mean dose equivalent rate for 26 crewmembers who flew a year or longer was 1.04 m-rem/hr. above 60,000 feet. They received an average of 51.9 m-rem per year which is 10.4% of the maximum permissible dose for the general population. The maximum radiation recorded for an individual in a year was 198 m-rem which is 39.6% of the MPD for the general population. Radiation received by crews flying at high altitudes should be acceptable in the absence of very intense solar activity. The standards for radiation workers, recommended by the International Commisson On Radiation Protection, can be conservatively applied to military aircrews flying high altitude missions. Personnel dosimetry should be routinely required because of the unpredictable nature of solar flare activity. A real-time warning system is required to advise crews flying at high altitudes of the occurrence of intense solar flare activity.

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In the spring of 1971 a long term study was begun at Beale Air Force Base, California for the purpose of defining the radiation hazard at the operational altitude of the SR-71, by monitoring the immediate environment of the crew with an accurate personnel dosimeter. Plans are to continue the study for at least one solar cycle if possible (10 - 12 yrs.).

Previous studies[1-3] suggested that the radiation doses received by the crew of a Super Sonic Transport (SST) should be acceptable in the absence of significant solar activity. Data gathered by sampling the high altitude environment during a number of balloon and aircraft flights, in addition to satellite experiments, theoretical calculations, and ground level neutron monitors, support this impression. Hopefully the present study will corroborate these early analyses and add to the knowledge about radiation in the high altitude environment.

This paper presents data gathered during the first eighteen months of the study which began April 1, 1971. The SR-71 aircraft and the medical support of the SR-71 program have been described elsewhere.[4-5]

MATERIALS AND METHODS

A thermoluminescent dosimeter (TLD) using lithium fluoride as the radiation sensor was supplied and calibrated by the USAF Radiological Health Laboratory (AFLC). The lithium fluoride sensor uses a special isotope of lithium (lithium-7) which is inert to temperatures well above 400°C. The TLD holder which is made of polypropolyne plastic and weighs about 8.6 grams was designed by Capt. H. V. Piltingsrud.

Each crewmember was provided a TLD which was placed in a pocket on the upper left sleeve of the outer garment of his pressure suit. The TLD

was worn on all flights and returned quarterly to the laboratory for dose determination. Replacement badges were furnished two weeks prior to the end of each three-month period. Two control badges, kept in the pressure suit storage room away from radiation sources, were returned each period with the other badges. Results of the readings from the dosimeters were recorded in the USAF Master Radiation Exposure Registry, and reported quarterly to the Aeromedical Service at Beale AFB, California.

During this eighteen month study (April 1971 through September 1972) forty-seven SR-71 crewmembers flew a total of 7000 hours in geomagnetic latitudes ranging from 10°N to 50°N. About 32.5% of this time (2275 hrs.) was at operational altitudes above 60,000 feet. An average of thirty crewmembers flew each quarter. Sixteen flew during the entire study.

RESULTS

Twenty-four crewmembers recorded total flying time and time above 60,000 feet over a six-month period. These data are summarized in Table I. An average of 32.5% of the flying time in the SR-71 is above 60,000 feet. This factor is applied to total flying time throughout the study to estimate flying time at operational altitudes. If the data in Table I are graphed on a histogram two peaks are obvious. The first occurs between 15.7% and 23.0% and involves new crews checking out in the SR-71. A greater proportion of the flying time during training is spent at lower altitudes practicing approaches and landings. Training flights average about 20.0% of the flying time above 60,000 feet. The second peak between 31.6% and 51.2% involves operational missions. These flights

are generally longer in duration and are usually terminated by a descent and landing, without practice approaches at lower altitudes. Operational flights average about 42.0% of the flying time above 60,000 feet.

Tables II through VII present the mean dose equivalent rates in millirem (m-rem) per hour above 60,000 feet recorded in each three-month period. Mean values for each crew member and each quarter are given. The lowest values observed were in the third and sixth quarters (Tables IV and VII). The mean values for each of these periods were 0.30 m-rem per hour. The highest individual dose rate recorded during these two quarters was 1.22 m-rem/hr. Only four out of fifty-six crew members flying during this time exceeded 1.0 m-rem/hr.

A mean dose equivalent rate of 2.13 m-rem/hr. was recorded during January through March 1972 (Table V). This was the highest quarterly value observed during the study. The highest total millirems for an individual during the study (176 m-rem) was recorded in this quarter. The maximum permissible dose (MPD) for radiation workers established by the International Commission On Radiation Protection (ICRP) is 5 rem per year or 3 rem per quarter.[6] The MPD for the general population is 0.5 rem per year (500 m-rem/year). 176 m-rem is 5.9% of the quarterly MPD allowed for radiation workers.

The highest mean dose equivalent rate observed in a quarter for an individual was 17.06 m-rem/hr. (Table VI). The maximum time an SR-71 crew member would spend above 60,000 feet in a year would only rarely reach 100 hours. If the dose rate of 17.06 m-rem/hr. was applied to this number then the crew member would receive about 1706.0 m-rem (1.7 rem) in a year. This is 34.1% of the MPD allowed for radiation

workers per year (5 rem). Actually, this individual (crew no. 11 in Table and VIII) received 190 m-rem for the eighteen-month period which is only 25.3% of the MPD for the general population.

Table VIII summarizes the total flying time and millirems received by twenty-six crew members who flew twelve months or longer during this study. They flew an average of 153.9 hours a year of which about 50 were above 60,000 feet. They received an average of 51.9 m-rem per year which is only 10.4% of the MPD for the general population, or 1.0% of the MPD for radiation workers. The highest total m-rems received by an individual in a year was 198 m-rems, which is 39.6% of the MPD for the general population. This crew member (crew no. 21) also had the highest dose equivalent rate (3.81 m-rem/hr.) observed in a twelve-month period. The mean dose equivalent rate for this group as a whole was 1.04 m-rem per hour above 60,000 feet.

Table IX summarizes total flying time and radiation exposure by quarter and for the study as a whole. The SR-71 flew 7000.1 hours during the eighteen-month period. About 2275.0 hours were flown above 60,000 feet. The TLD recorded a total of 2238.5 m-rems. The mean dose equivalent rate for the entire study was 0.98 m-rem per hour above 60,000 feet.

DISCUSSION

The radiation encountered by SR-71 crews during this study was negligible. The mean dose equivalent rate for twenty-six crew members who flew a year or longer was 1.04 m-rem/hr. above 60,000 feet. It would be unusual for an individual to fly operationally in the SR-71 program for longer than five years, or exceed 500 hours above 60,000 feet. A crew member, participating maximally in the program, would

receive 520 m-rem in a five year period at the dose rate indicated above. This is only 2% of the MPD for radiation workers. The maximum dose equivalent rate recorded for an individual in a year was 3.61 m-rem/hr. A crew member would receive 1905.0 m-rem in five years at this dose rate. This is 7.6% and 76.2% of the MPD for radiation workers and the general population respectively.

On the other hand it must be noted that the majority of the SR-71 flights in this study were in geomagnetic latitudes from 10°N to 50°N. Cosmic radiation is most intense in the polar regions at latitudes greater than 55°N. It has been estimated that the dose rate encountered at SST altitudes in polar and equatorial regions could vary by a factor of five to six. Therefore, any significant shift in the flight profiles of the SR-71 to more northernly latitudes could produce a different set of data. Furthermore, this eighteen-month study represents only about 14% of an average solar cycle of 10.5 to 11 years. The period of observations is too short to define with any reasonable accuracy the mean dose equivalent rate for an entire solar cycle.

There are three types of radiation which could be encountered while flying in the high altitude environment:

1. radiations from nuclear explosions in the atmosphere.
2. galactic cosmic radiation (GCR)
3. solar cosmic radiation (SCR)

The probability of being exposed to radiation from nuclear explosions in the atmosphere without prior warning is remote in peacetime. Galactic cosmic radiation is quantitatively the most important source of radiation for crews who routinely fly at SST altitudes. The dose rate from GCR is

continuous and predictable. The average galactic dose equivalent rate during a solar cycle has been estimated to be about 1.1 to 1.2 m-rem per hour at 65,000 feet and latitudes greater than 60°N.

Radiation from solar cosmic radiation is sporadic and unpredictable. The average dose rate from SCR during a solar cycle has been estimated (for solar cycle 19) to be about 0.7 m-rem per hour. Therefore, SCR is not quantitatively as important as GCR over the long term. However, in February 1956 a giant solar flare was observed which generated a dose equivalent rate of between 0.5 and 3.0 rem per hour at SST altitudes in high latitudes. The dose rates from several other high energy events during solar cycle 19 (1954-1964) varied between 10 and 50 m-rem per hour. Fortunately intense solar events similar to the one in Feb. 1956 occur only one or two times per solar cycle. Therefore it is extremely unlikely that an SR-71 crewmember would be exposed to one.

Galactic and solar cosmic radiation is primarily composed of protons (85%), alpha-particles (helium nuclei), and other heavier nuclei. These primary particles collide with nuclei of gases in the upper atmosphere and produce a complex array of secondary particles. The most important part of this secondary flux are neutrons which contribute more than half the dose equivalent at SST altitudes. This has important implications related to the problem of accurately recording the radiation received at high altitudes with a personnel dosimeter such as the TLD. The response of the TLD to neutron radiation is difficult to interpret. For this reason the laboratory developed a neutron spectrometer-dosimeter which is designed to more precisely measure the flux and energy spectra of neutrons in mixed radiation fields.[7] Plans are to use this device

in the near future to cross-calibrate the TLD at operational altitudes of the SR-71.

Finally, several tentative conclusions and recommendations are offered for consideration:

1. The initial observations in this study support the conclusions of earlier studies that the radiation received by air crews, flying in the high altitude environment, should be acceptable in the absence of significant solar activity.

2. SR-71 crews, as well as other military crews selected to participate in high altitude missions, are in excellent health. Furthermore, they generally do not participate in high altitude programs for longer than five years. For these reasons the standards for radiation workers, recommended by the International Commission on Radiation Protection, can be conservatively applied to military aircrews who routinely fly in the high altitude environment.

3. Personnel dosimetry should be required for all military crew members participating in high altitude missions because of the unpredictable nature of solar flare activity. Results of readings from the dosimeters should be made a permanent part of their medical records.

4. The most significant radiation hazard to high altitude air crews is the infrequent occurrence of giant solar flares similar to the one in February 1956. The high energy particle flux during this event reached its peak in the earth's atmosphere twenty minutes after it was initially observed. For this reason a real-time warning system is required. Ideally, the warning would be transmitted to the crews at high altitudes by the flight control centers which are monitoring their flight

progress. Prompt descent to lower altitudes (30,000 feet) provides significant protection.

ACKNOWLEDGEMENTS

The author wishes to express his gratitude to Col. Lawrence T. Odland and Capt. H. V. Piltingsrud of the USAF Radiological Health Laboratory, Wright-Patterson AFB, Ohio. The original idea for this study was theirs. The thermoluminescent dosimeter holder was developed and tested under their guidance and supervision. The quarterly readings of the TLD badges were accomplished by the laboratory. This paper could not have been written without their extensive contributions.

The author would also like to thank Dr. John Dula, of the Aeromedical Service at Beale AFB, California, for his help in the initial organization of the data. Appreciation is also extended to the SR-71 crew members and the personnel of the Physiological Support Division at Beale AFB, Ca. for their assistance in collecting and recording the data presented in this study.

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TABLE I. PER CENT TIME ABOVE 60,000 FEET, APRIL-SEPTEMBER 1972.

Crew No.	Total Time	Time Above 60m	% Time Above 60m
1	34.3	5.4	15.7
2	63.8	10.5	16.5
3	56.5	10.5	18.6
4	62.0	12.5	20.2
5	47.9	10.3	21.5
6	76.6	16.9	22.1
7	45.3	10.3	22.7
8	74.2	16.9	22.8
9	52.5	12.1	23.0
10	34.5	10.9	31.6
11	62.2	23.0	37.0
12	62.2	23.0	37.0
13	10.8	4.2	38.9
14	39.9	15.9	39.8
15	64.7	25.8	39.9
16	26.4	10.7	40.5
17	26.4	10.7	40.5
18	25.5	10.7	42.0
19	45.2	19.6	43.4
20	51.5	24.1	46.8
21	51.5	24.1	46.8
22	55.8	26.3	47.1
23	51.5	26.3	49.3
24	20.9	10.7	51.2
Total	1144.0	371.4	32.5

TABLE II. MILLIREM PER HOUR ABOVE 60,000 FEET. APRIL-JUNE 1971.

Crew No.	Total Time	Time Above 60m	MR	MR/hr. Above 60m
1	43.1	14.0	10.0	0.71
2	42.0	13.7	10.0	0.73
3	39.9	13.0	14.0	1.08
4	47.6	15.5	17.0	1.10
5	40.5	13.2	27.0	2.05
6	39.4	12.8	20.0	1.56
7	32.6	10.6	25.0	2.36
8	39.8	12.9	10.0	0.78
9	39.0	12.7	8.0	0.63
10	46.1	15.0	8.0	0.53
11	38.7	12.6	12.0	0.95
12	24.6	8.0	11.0	1.38
13	49.1	16.0	13.0	0.81
14	65.3	21.2	19.0	0.90
15	46.7	15.2	17.0	1.12
16	44.4	14.4	0.0	-
17	43.5	14.1	13.0	0.92
18	63.9	20.8	18.0	0.87
19	40.0	13.0	16.0	1.23
20	42.1	13.7	12.0	0.88
21	39.9	13.0	13.0	1.00
22	37.8	12.3	11.0	0.89
23	47.2	15.3	31.0	2.03
24	52.0	16.9	22.0	1.30
25	38.2	12.4	29.0	2.34
26	19.8	6.4	7.0	1.09
27	41.9	13.6	8.0	0.59
28	31.7	10.3	8.0	0.78
29	38.3	12.4	11.0	0.89
30	19.0	6.2	17.0	2.74
31	25.6	8.3	11.0	1.33
32	40.8	13.3	19.0	1.43
33	40.1	13.0	12.0	0.92
34	34.0	11.1	10.0	0.90
Total	1374.6	446.7	489.0	1.09

TABLE III. MILLIREM PER HOUR ABOVE 60,000 FEET. JULY-SEPTEMBER 1971.

Crew No.	Total Time	Time Above 60K	MR	MR/hr. Above 60K
1	31.8	10.3	19.0	1.84
2	26.6	8.6	18.0	2.09
3	32.6	10.6	22.0	2.08
4	29.3	9.5	8.0	0.84
5	58.2	18.9	12.0	0.63
6	53.0	17.2	12.0	0.70
7	40.6	13.2	10.0	0.76
8	42.9	13.9	24.0	1.73
9	48.3	15.7	26.0	1.66
10	49.5	16.1	13.0	0.81
11	33.1	10.8	2.0	0.19
12	58.0	18.9	15.0	0.79
13	43.7	14.2	10.0	0.70
14	48.6	15.8	12.0	0.76
15	24.8	8.1	4.0	0.49
16	38.4	12.5	10.0	0.80
17	38.2	12.4	4.0	0.32
18	35.8	11.6	37.0	3.19
19	47.9	15.6	6.0	0.38
20	26.6	8.6	28.0	3.26
21	41.9	13.6	9.0	0.66
22	26.2	8.5	2.0	0.24
23	44.2	14.4	3.0	0.21
24	28.7	9.3	2.0	0.22
25	32.4	10.5	18.0	1.71
26	29.3	9.5	18.0	1.89
27	8.3	2.7	6.0	2.22
28	26.0	8.5	23.0	2.71
29	20.8	6.8	29.2	4.29
30	20.3	6.6	0.0	-
Total	1086.0	353.0	402.2	1.14

TABLE IV. MILLIREM PER HOUR ABOVE 60,000 FEET. OCTOBER-DECEMBER 1971.

Crew No.	Total Time	Time Above 60m	MR	MR/hr. Above 60m
1	49.8	16.2	2.0	0.12
2	34.1	11.1	0.0	-
3	24.2	7.9	0.0	-
4	41.0	13.3	14.0	1.05
5	30.2	9.8	0.0	-
6	30.2	9.8	0.0	-
7	34.5	11.2	1.0	0.09
8	36.6	11.9	1.0	0.08
9	31.4	10.2	0.0	-
10	38.8	12.6	7.0	0.56
11	47.9	15.6	6.0	0.38
12	35.6	11.6	6.0	0.52
13	40.6	13.2	0.0	-
14	34.1	11.1	9.0	0.81
15	29.6	9.6	5.0	0.52
16	39.9	13.0	1.0	0.08
17	30.4	9.9	0.0	-
18	30.8	10.0	7.0	0.70
19	30.1	9.8	12.0	1.22
20	17.8	5.8	0.0	-
21	37.3	12.1	0.0	-
22	41.0	13.3	0.0	-
23	33.3	10.8	0.0	-
24	27.7	9.0	10.0	1.11
25	33.0	10.7	0.0	-
26	29.7	9.7	1.0	0.10
27	38.5	12.5	10.0	0.80
28	30.4	9.9	0.0	-
Total	958.5	311.5	92.0	0.30

TABLE V. MILLIREM PER HOUR ABOVE 60,000 FEET. JANUARY-MARCH 1977.

Crew No.	Total Time	Time Above 60m	MR	MR/hr. Above 60m
1	49.7	16.2	9.0	0.56
2	39.0	12.7	6.0	0.47
3	36.9	12.0	43.0	3.58
4	31.4	10.2	78.0	7.65
5	29.1	9.5	5.0	0.53
6	26.9	8.7	5.0	0.57
7	38.8	12.6	7.0	0.56
8	47.2	15.3	31.0	2.03
9	38.3	12.4	16.0	1.29
10	24.2	7.9	6.0	0.76
11	40.1	13.0	50.0	3.85
12	24.9	8.1	9.0	1.11
13	31.9	10.4	7.0	0.67
14	46.8	15.2	10.0	0.66
15	31.3	10.2	8.0	0.78
16	28.1	9.1	6.0	0.66
17	29.9	9.7	3.0	0.31
18	37.2	12.1	54.0	4.46
19	34.9	11.3	19.0	1.68
20	24.5	8.0	40.0	5.00
21	40.8	13.3	176.0	13.23
22	34.9	11.3	8.0	0.71
23	42.3	13.7	9.0	0.66
24	24.2	7.9	23.0	2.91
25	48.8	15.9	46.0	2.89
26	26.1	8.5	5.0	0.59
27	32.9	10.7	33.0	3.08
28	6.5	2.1	6.0	2.86
29	40.1	13.0	35.0	2.69
30	30.3	9.8	5.0	0.51
31	34.2	11.1	6.0	0.54
32	34.2	11.1	5.0	0.45
33	9.9	3.2	3.0	0.94
34	24.5	8.0	4.0	0.50
Total	1120.8	364.3	776.0	2.13

TABLE VI. MILLIREM PER HOUR ABOVE 60,000 FEET. APRIL-JUNE 1972.

Crew No.	Total Time	Time Above 60m	MR	MR/hr. Above 60m
1	39.9	13.0	6.0	0.46
2	39.1	12.7	14.3	1.13
3	28.7	9.3	2.0	0.22
4	62.2	20.2	6.0	0.30
5	17.3	5.6	8.0	1.43
6	18.1	5.9	0.0	-
7	45.2	14.7	5.0	0.34
8	28.2	9.2	9.0	0.98
9	22.6	7.3	2.0	0.27
10	51.5	16.7	4.0	0.24
11	21.0	6.8	116.0	17.06
12	51.5	16.7	6.0	0.36
13	18.1	5.9	19.0	3.22
14	64.7	21.0	11.0	0.52
15	63.8	20.7	0.0	-
16	13.1	4.3	14.0	3.26
17	55.8	18.1	7.0	0.39
18	15.0	4.9	4.0	0.82
19	16.3	5.3	2.0	0.38
20	3.0	1.0	2.0	2.00
21	26.4	8.6	14.0	1.63
22	26.4	8.6	9.0	1.05
23	62.2	20.2	6.0	0.30
24	7.9	2.6	32.0	12.31
25	53.4	17.4	5.0	0.29
26	63.8	20.7	10.0	0.48
27	56.5	18.4	6.0	0.33
28	37.1	12.1	10.0	0.83
29	37.1	12.1	10.0	0.83
Total	1045.9	339.9	339.3	1.00

TABLE VII. MILLIREM PER HOUR ABOVE 60,000 FEET. JULY-SEPTEMBER 1972.

Crew No.	Total Time	Time Above 60m	MR	MR/hr. Above 60m
1	5.4	1.8	2.0	1.11
2	4.0	1.3	1.0	0.77
3	25.5	8.3	4.0	0.48
4	34.3	11.1	5.0	0.45
5	52.5	17.1	5.0	0.29
6	34.0	11.1	5.0	0.45
7	68.7	22.3	7.0	0.31
8	91.8	29.8	8.0	0.27
9	65.4	21.3	5.0	0.23
10	79.8	25.9	8.0	0.31
11	47.9	15.6	4.0	0.26
12	83.2	27.0	8.0	0.30
13	66.1	21.5	4.0	0.19
14	38.1	12.4	6.0	0.48
15	10.8	3.5	3.0	0.86
16	61.5	20.0	4.0	0.20
17	67.1	21.8	4.0	0.18
18	67.5	21.9	5.0	0.23
19	45.3	14.7	5.0	0.34
20	20.9	6.8	2.0	0.29
21	59.5	19.3	6.0	0.31
22	76.6	24.9	4.0	0.16
23	74.2	24.1	5.0	0.21
24	45.2	14.7	7.0	0.48
25	63.9	20.8	8.0	0.38
26	28.6	9.3	6.0	0.65
27	34.5	11.2	5.0	0.45
28	62.0	20.2	4.0	0.20
Total	1414.3	459.6	140.0	0.30

TABLE VIII. SUMMARY OF FLYING TIME AND MILLIREM FOR TWENTY SIX CREWMEMBERS. APRIL 1971 THROUGH SEPTEMBER 1972.

Crew No.*	Total Time	Time Per Year	Total MR	MR Per Year	Time Above 60m/year	MR/hr. Above 60m
1	219.7	146.5	48.0	32.0	47.6	0.67
2	184.8	123.2	49.3	[illegible]	40.0	1.00
3	187.8	125.2	85.0	56.7	40.7	1.39
4	245.8	163.9	128.0	85.3	53.3	1.60
5	227.8	151.9	57.0	38.0	49.4	0.77
6	201.6	134.4	42.0	28.0	43.7	0.64
7	260.4	173.6	55.0	36.7	56.4	0.65
8	286.5	191.0	83.0	55.3	62.1	0.89
9	245.0	163.3	59.0	39.3	53.1	0.74
10	289.9	193.3	46.0	30.7	62.8	0.49
11	228.7	152.5	190.0	126.7	49.6	2.55
12	277.8	185.2	56.0	37.3	60.2	0.62
13	249.5	166.3	53.0	35.3	54.0	0.65
14	297.6	198.4	67.0	44.7	64.5	0.69
15	207.0	138.0	37.0	24.7	44.9	0.55
16	225.4	150.3	35.0	23.3	48.8	0.48
17	197.8	158.2	27.0	21.6	51.4	0.42
18	182.7	146.2	120.0	96.0	47.5	2.02
19	169.2	135.4	55.0	44.0	44.0	1.00
20	114.0	91.2	84.0	67.2	29.6	2.27
21	159.9	159.9	198.0	198.0	52.0	3.81
22	195.6	156.5	28.0	22.4	50.9	0.44
23	213.7	171.0	26.0	20.8	55.6	0.37
24	125.9	125.9	40.0	40.0	40.9	0.98
25	172.9	138.3	77.0	61.6	44.9	1.37
26	162.5	162.5	43.0	43.0	52.8	0.81
Total	5529.5	4002.1	[illegible]	1348.5	1300.7	-
Mean	212.7	153.9	68.8	51.9	50.0	1.04

* Crew No. 1-16 flew during the entire period. Crew No. 17-26 flew twelve months or more.

TABLE IX. SUMMARY OF TOTAL [illegible] TIME AND [illegible] BY QUARTER.
APRIL 1971 THROUGH SEPTEMBER 1972.

Time Period	Total Time	Time Above 60m	MR	MR/hr. Above 60m
Apr-June 71	1374.6	446.[illegible]	489.0	1.09
July-Sept 71	1086.0	353.0	402.2	1.14
Oct-Dec 71	958.5	311.5	92.0	0.30
Jan-Mar 72	1120.8	364.3	776.0	2.13
Apr-Jun 72	1045.9	339.[illegible]	339.3	1.00
July-Sept 72	1414.3	459.6	140.0	0.30
Totals	7000.1	2275.0	2238.5	0.98